Magnitude of Available Short-Circuit Current

Figure 6 shows maximum values of available short-circuit current at the secondary terminals of some typical sizes of building main service transformers. Note, the increased values of amperes when three single-phase transformers are connected for three-phase operation. For this situation, the percent internal impedance (%Z) of the three transformers must be matched. The three-phase %Z is the same as for one of the single transformers.

Transformer KVA Size	System Voltage		
	Single-Phase 120/240V	Three-Phase 120/208V	Three-Phase 277/480V
37-1/2	18,000 A.	–	–
50	22,000 A.	–	–
100	44,000 A.	18,000 A.	8,000 A.
250	82,000 A.	40,000 A.	18,000 A.
333	98,000 A.	–	–
500	184,000 A.	82,000 A.	35,000 A.
750	–	42,000 A.	18,000 A.
750*	–	122,000 A.	53,000 A.
1000	–	56,000 A.	24,000 A.
1000*	–	132,000 A.	57,000 A.

*Three-single-phase transformers.

Figure 6

The following equation was used to calculate Figure 6 values:

$$I = \frac{100\%}{\%Z} \times \text{Transformer secondary full load amps}$$

Refer to Table Z page A18 for typical lowest transformer percent impedance (%Z) used to find short circuit values.

Many congested commercial building areas have underground low voltage network systems for multiple building service connections. Available fault current may approach 200,000 I_{rms}.

The fault current values will be reduced by utility KVA capability and impedance in a power distribution system.

Symmetrical and Asymmetrical Short-Circuit Current

When correctly selected overcurrent protection devices are used there is no practical reason for an electrical power system designer to be concerned about values of asymmetrical short-circuit amperes available unless there is reason to believe that a system has a ratio of inductive reactance to resistance higher than UL test values for equipment short circuit ratings, circuit breaker or current limiting fuses interrupting ratings.

Current limiting fuse manufacturers typically test directly across a fuse at 460,000 peak asymmetrical amperes for a UL interrupting rating listing at 200,000 RMS symmetrical amperes. A designer may want to refer to UL Standard 489 for testing of molded case circuit breakers.

It may be confusing that most industry references to shortcircuit current and short-circuit ratings are in “RMS symmetrical amperes” (I_{rms}), but this is for convenience and common understanding that the “worse case” requirements imposed by “asymmetrical” values are “built-in” for UL testing.

Figure 7 shows the relationship between two cycles of symmetrical and asymmetrical current at the typical “worst case” power system Asymmetry Factor of 2.3. When considering that current limiting fuses, in sizes 3000A or less, will interrupt the current shown in Figure 7 before the peak of the first one-half cycle, this subject is of little value unless non-limiting devices are specified.

Fuse Current Limitation

Refer to Figure 8 for a description of fuse current limitation. The LENRK 600 fuse limitation indicated by the small hatched area is compared to two cycles of fault current flow as indicated by the dashed line.

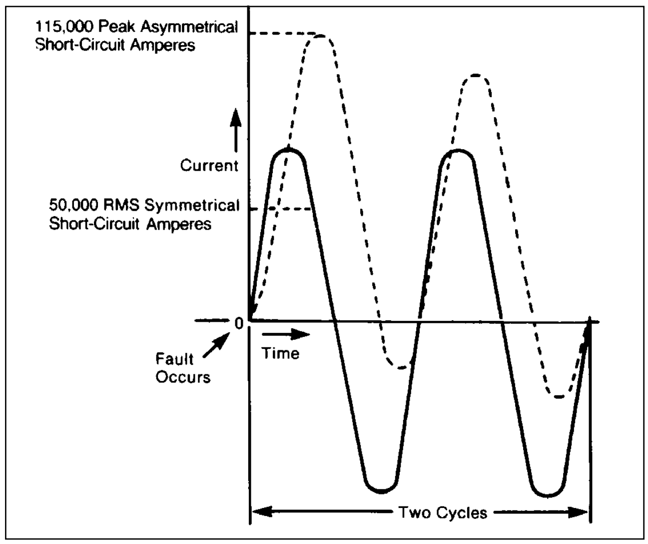

Figure 7

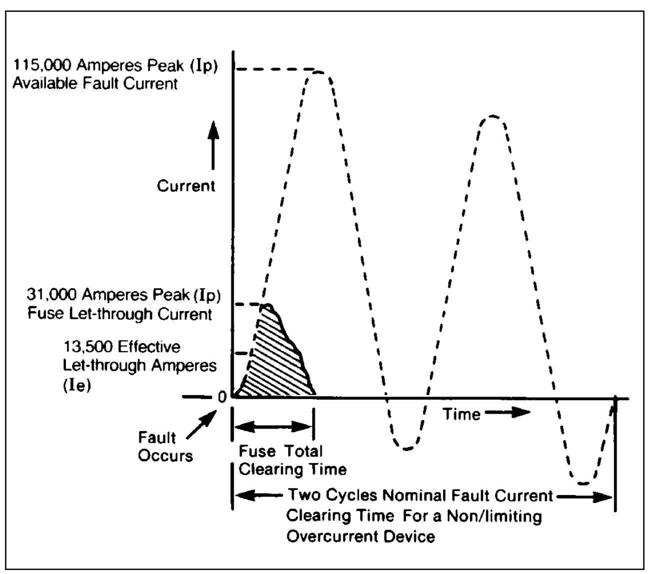

Figure 8

Short-Circuit Protection Comparison of EDISON LENRK 600 Current Limiting Fuses vs. Non/Limiting Overcurrent Protection Devices with 50,000 RMS Amperes Short-Circuit Current Available.

Fault current flow through conducting paths to a fault location produces two major potentially damaging effects to equipment, components and conductors:

a) Magnetic fields between conductors produce magnetic stress (physical force). Physical bracing is required with the extent (cost) dependent on the magnitude of fault current allowed to flow. Force varies directly with the square of the maximum peak (I_p) current during the first one-half cycle.

b) Fault current flow causes thermal stress (excess heat) in conducting paths dependent on the magnitude of RMS (I_{rms}) or effective (I_e) current squared multiplied by the time of current flow (I^2t).

In the Figure 8 illustration, the LENRK 600 fuses reduce the physical magnetic force between conductors to about 8% of that allowed by a non-limiting device.

The LENRK 600 fuses reduce I^2t thermal stress reference over 14,500% less than allowed by a non-limiting device.

Any potentially damaging arcing at the fault location will also be reduced.

Specifying EDISON current limiting fuses provides excellent protection by reducing short-circuit current energy allowed to flow to a fault. Thus, the requirements of NEC 110.10 and article 240 can be met.

UL provides a service to equipment manufacturers for listing short-circuit current ratings at any of the optional maximum values shown in Figure 9.

This provides a means for power system designers to specify minimum short-circuit ratings to meet NEC 110.10.

UL Short-Circuit Ratings for Electrical Equipment

The term "Equipment" includes switchboards, panelboards, motor control centers, busway and motor controllers.

Standard UL Equipment Short-Circuit Current Ratings in RMS Amperes*	
14,000	65,000
18,000	75,000
22,000	85,000
25,000	100,000
30,000	125,000
35,000	150,000
42,000	200,000
50,000	

*Contact manufacturer for availability of ratings.

Figure 9

Maximum Allowable UL Let-Through Values for Fuses at 100,000 RMS Symmetrical Amperes*

UL Fuse Class	Fuse Rating, Amperes	UL Let-Through	
		$I_p \times 10^3$	$I^2t \times 10^3$
CC	**30**	**7.5**	**7**
J	30	7.5	7
	60	10	30
	100	14	80
	200	20	300
	400	30	1,100
	600	45	2,500
RK1	30	10	10
	60	12	40
	100	16	100
	200	22	400
	400	35	1,200
	600	50	3,000
RK5	30	11	50
	60	21	200
	100	25	500
	200	40	1,600
	400	60	5,000
	600	80	10,000
L	800	80	10,000
	1200	80	12,000
	1600	100	22,000
	2000	120	35,000
	2500	165	75,000
	3000	175	100,000
	4000	220	150,000
	5000	–	350,000
	6000	–	350,000

*UL tests current limiting fuses at 50,000, 100,000 and 200,000 RMS symmetrical amperes.

Figure 10

UL testing and listing of equipment protected by current limiting fuses is done with fuses that have the same current limiting performance as the maximum allowable peak let-through current when any fuse manufacturer submits current limiting fuses for testing and listing. The result is that any brand of UL listed fuses may be used to protect UL short-circuit rated equipment within the specified limit of short-circuit rating.